DOCUMENT RESUME

ED 329 804 CE 057 450

AUTHOR de Assis, Marisa
TITLE Brazil: Implications of Technological Change for Skills Training in Sao Paulo Industries. Training Discussion Paper No. 47.
INSTITUTION International Labour Office, Geneva (Switzerland).
REPORT NO ISBN-92-2-107432-3
PUB DATE 90
NOTE 47p.
PUB TYPE Reports - Research/Technical (143)

EDRS PRICE MF01 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS Adult Education; Elementary Secondary Education; Foreign Countries; Industry; Job Skills; Labor Market; *Labor Needs; Nonformal Education; Postsecondary Education; *Role of Education; *Technological Advancement; Technological Literacy; *Technology Transfer; *Vocational Education
IDENTIFIERS *Brazil

ABSTRACT

The Brazilian economy is led by the industrial sector, which accounts for 34 percent of production and employs 25 percent of the economically active population. The labor force formally employed in industry consists mainly of relatively young males with little schooling. A large number of institutions both in the regular education system and nonformal sector provide vocational education. The main institutions offering nonformal training are the National Service of Industrial Apprenticeship, firms benefiting from tax incentives provided by Law 6.297, and independent vocational schools. Dissemination of new technologies in Brazil is slow, and their use is much less common than in advanced countries. New technologies are attractive to Brazilian industry for reasons of increased productivity and improved product quality. Reduction of labor costs is unimportant. New technologies in the machine tool, printing, textile, and construction industries have changed or created labor needs. Introduction of new technologies produces four different types of effects on job content and employment: job restructuring, job maintenance, job creation, and job destruction. Vocational training needs to complement conventional training with the specific training required for working with new technologies and train workers with basic education and training to use technologically advanced equipment. (50 references) (YLB)

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Discussion Paper No. 47

BRAZIL: IMPLICATIONS OF TECHNOLOGICAL CHANGE FOR SKILLS AND TRAINING IN SAO PAULO INDUSTRIES

by Marisa de Assis

edited by the Training Policies Branch of ILO Geneva

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LIMITED DISTRIBUTION

March 1990

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ISBN 92-2-107432-3

First published 1990

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Printed by the International Labour Office, Geneva, Switzerland

PREFACE

This paper was prepared at the request of the International Labour Organisation (ILO), as part of a study on the implications of technological change for vocational training in recently industrialised countries. The project covers five other countries in addition to Brazil; they are Hong Kong, India, Ireland, Venezuela and Yugoslavia.

The general purpose of the ILO study is to identify the measures adopted by these countries in order to stimulate the production and dissemination of technological innovations, to train manpower and to bring about structural changes in the economy and in labour organisation. The study pays special attention to policies and programmes for education and vocational training.

Brazil is an interesting case for the analysis of these matters. The country's economic performance has assured it a good position internationally, but regional disparity within the country is such that some areas are well developed, with economic and social indicators similar to those of advanced countries, while other areas remain underdeveloped.

Brazil's industry is already very diversified, with a considerable number of state-of-the-art industries. The country is slowly beginning to incorporate new technologies, particularly in the more developed regions. Although industry is being modernised by the introduction of advanced equipment, this does not replace traditional technology but coexists with it in the production process.

The part of the study which analyses the level of dissemination of new technologies and their impact on vocational training is based mainly on data from research carried out by the National Service of Industrial Apprenticeship (SENAI) in the State of Sao Paulo. This research project was carried out from 1984 to 1987 and covered 63 different companies in the State. Sao Paulo was selected for the survey because this State has always been the leader in the industrialisation of Brazil and is at present responsible for 53 per cent of the value of domestic industrial production and for 45 per cent of employment in the industrial sector. In addition, a high percentage of the technologically more advanced industries in Brazil are located in this state, which gives it an important role in the dissemination of technological innovations.

This paper was originally written in Portuguese. The vocabulary used in the English version is not necessarily a direct translation of the original, but was chosen to conform to ILO usage.

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1. THE BRAZILIAN ECONOMY

1.1 The historical development of industry

In the nineteenth century the Brazilian economy was based on the export of a small number of primary products, notably coffee. This meant that the visibility of the economy was linked to foreign demand, so that Brazil "imported" the economic crises of the countries on which it depended and was at the mercy of fluctuations in the international prices of its products.

Until the 1940s Brazil was still essentially an agricultural country, with approximately 66 per cent of its economically active population working in the primary sector and about 70 per cent of its inhabitants living in rural areas.

The 1950s marked a new era in the Brazilian economy, with the industrial sector, particularly manufacturing, taking the lead. Until then industrialisation had been slow, driven by a few traditional branches such as textiles, footwear, clothing and food, but with little government interest or support for industrialising the country. It was only during the second half of the 1950s that a real industrialisation strategy began to appear and government policy sought to overcome bottlenecks that were hindering development and to create an infrastructure that would permit industrial expansion.

The desire to develop the country by means of industrial expansion was influenced by the prevailing economic thinking. For example, the Economic Commission for Latin America (ECLA) identified the problems of Latin America as slow growth in the export of primary products, high population growth and the beginning of migration to urban areas. ECLA maintained that the solution to these problems lay in industrialisation through import substitution. Far- reaching changes occurred in the country as a result of this new orientation of the economy; employment in the primary sector dropped to approximately 30 per cent and the rate of urbanisation rose to almost 68 per cent.

Since the late 1950s manufacturing has shown geometrically rising annual growth rates both in employment and in production; the rates have almost always been higher than those for total employment and GDP. This performance would have been even more favourable were it not for the weakness of the consumer goods sector. Until 1962 this branch expanded rapidly due to import substitution, but after that recession and flattening wage levels limited its growth and new expansion only started again in the 1970s.

Industrial activity stimulated the service sector, especially transport, communications, wholesaling and certain commercial

and financial services. The vitality and importance of this sector was thus closely linked with industry, particularly manufacturing. From 1960 to 1980 the service sector represented between 53 and 57 per cent of GDP and employed between 33 and 45 per cent of the economically active population.

Since the beginning of the 1980s the world economy has been in a recession which has hit Latin American countries particularly hard. Their GDP has practically stagnated and debt servicing has consumed a considerable portion of national income. For Brazil the 1980s represent an economic crisis without precedent, with negative growth rates recorded between 1981 and 1983. The recession will be difficult to overcome in view of continuing difficulties in the world economy, which even affect the more developed countries.

An historical analysis of the performance of the Brazilian economy shows that its evolution is characterised by a succession of short stages of strong growth followed by violent slumps. Since the second half of the 1950s, when the industrial development of the nation was effectively launched, the periods 1956-61 and 1968-73 saw phases of rapid expansion during which the economy grew by as much as 14 per cent per annum. The years 1979-80 and 1984-85 were times of more modest growth lasting for a very short while; these were years of transition between phases of growth and depression. The periods 1962-67, 1974-78, 1981-83 and the years since 1985 are the crisis years of the Brazilian economy, evidenced by falling growth rates which reached their lowest point between 1981 and 1983 when negative growth was recorded (in 1981 the growth rate fell to -3.4 per cent).

The above data clearly demonstrate the state of constant flux of the country's economy, which makes it difficult to undertake medium and long-term planning . However, the data also illustrate the great flexibility of the economy, which has responded very rapidly, either positively or negatively, to changes in the international situation and to government measures.

Despite its chronic instability the economy has advanced over the years to such a point that Brazilian industry is now among the ten largest in the world.

1.2 The geographical concentration of industry

Brazil's early industrialisation was hampered by fluctuations in the price of coffee on the international market. The potential for industrialisation appeared when external depreciation of the currency, carried out with the aim of maintaining the profitability of exports, caused increases in the price of imported manufactured goods. Domestic demand for such goods stimulated capital investment in industries capable of producing them, i.e., labour-intensive industries that demanded little investment in machinery.

This situation created opportunities for investing some of the profits produced by coffee. Coffee planters had already begun to diversify their interests into the finan-

cial, commercial and political aspects of the coffee trade, and were prepared to move into financing new industries. They realised that the policy of artificially supporting coffee prices could eventually have a negative effect on the coffee trade.

Thus the birth of Brazilian industry was closely related to coffee planting, and it was also due to coffee that industrialisation began in Sao Paulo, the State in which coffee planting originally expanded. Apart from generating a surplus which could be invested in industry, coffee planting had created a transport and communications network connecting the capital to the interior and to other states. This factor encouraged the development of a market economy.

In terms of increased purchasing power, Sao Paulo became one of the most progressive states in the country and consequently soon became a flourishing domestic consumer market. This encouraged a strong migratory flow; immigrants expanded the domestic market both through increased numbers and through the introduction of new consumption habits; they also supplied a large proportion of the necessary labour, as many were skilled workers and artisans in their country of origin. A further important element was the fact that Sao Paulo had an abundant supply of electricity and raw materials, especially cotton for the textile industry which for some time was the main activity.

From these beginnings Sao Paulo gradually became an "advanced nucleus" of industrialisation, with growth rates surpassing those of all other Brazilian states.

Until the mid-1970s employment in the industrial sector rose continuously in Sao Paulo and the state accounted for a constantly increasing proportion of Brazil's GDP. Since then its growth rates have been slightly below those of the rest of the country, but even so its position of leadership has remained virtually unaltered and it has withstood several government attempts to "deconcentrate" the area. In 1980 the state of Sao Paulo accounted for no less than 45 per cent of employment and 53 per cent of the value of industrial production in Brazil.

It should be pointed out that the great industrial concentration in the area which was, historically, already the most developed of the country, has contributed to deepening regional imbalances, with all the economic, political and social implications that this entails. Brazil today is a country of great inequities, reflected in the disparity in levels of employment, schooling, mortality, health and income between the different states.

1.3 Sectoral concentration

Generally speaking, industrialisation in Brazil followed the "logic" of the capitalist system, namely that consumer goods industries tend to precede capital goods industries. Thus the first branches of industry to appear were textiles, food, clothing and footwear. For a considerable time the greatest share of employment and value of production were concentrated in these in-

dustries, particularly textiles and food. Between 1939 and 1949, for example, these two branches alone were responsible for approximately 50 per cent of the value of industrial production and 45 per cent of employment.

Diversification started about 1950 and the textile and food industries began to decline, with the value of production falling to 18 per cent of GDP in 1980 and the share of employment decreasing to 20 per cent the same year. However, by 1959 considerable expansion was already taking place in the mechanics, metallurgical, electrical and chemical branches of industry. In terms of value produced the share of this group rose from approximately 18 per cent in 1939, to 33 per cent in 1959 and to 54 per cent in 1980. Employment also rose from 14 per cent in 1939 to 25 per cent in 1959 and to 36 per cent in 1980. Diversification meant that the production of consumer goods lost its predominance to the manufacture of capital goods. At present the leaders in Brazilian industry are chemicals, food products, metallurgy and transportation material, which together account for 55 per cent of the value of production. Food products, metallurgy, mechanical goods, clothing, footwear and textiles between them employ 44 per cent of the industrial labour force, with food products and metallurgy as the main employers. In summary, the Brazilian economy is led at present by the industrial sector, which accounts for 34 per cent of production and employs 25 per cent of the economically active population.

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2. THE LABOUR FORCE IN BRAZIL

2.1 Geographical distribution

In the mid-1980s the population of Brazil was estimated at 131 million, very unequally distributed over the country. The largest region geographically is the north, which covers 42 per cent of the total area of Brazil, but has only 3 per cent of the population, while the south-east, which covers only 11 per cent of the territory, has 45 per cent of the population. The distribution of the population is closely related to the economic potential of the various regions. As we have already seen in the State of Sao Paulo alone, the south-east accounts for 53 per cent of the industrial production of Brazil and 45 per cent of employment in the industrial sector. This region also concentrates almost half of the country's population.

Of the 131 million inhabitants of Brazil, approximately 88 million are over 14 years of age and could, theoretically, be included in the labour market. In fact, about 49 per cent of this group are engaged in some form of economic activity, or are seeking work.

The service sector is the main employer in Brazil, absorbing 46 per cent of the active labour force. Next in importance is the primary sector, and last is the industrial sector which absorbs 25 per cent of workers in Brazil. Over the last 30 to 40 years there has been a fundamental change in the job structure in Brazil, accompanying the industrial development that has occurred since the 1950s. In 1950 the primary sector was the largest employer, with 60 per cent of the labour force. During the next 20 years it declined steadily and in 1970 the service sector took the lead. It should be noted that the decline of the primary sector corresponded not only to growth in the service sector, where employment rose from 26 to 46 per cent of the total, but also to growth in the industrial sector, where employment rose from 14 to 25 per cent. The redistribution of employment was clearly associated with the country's economic development policy, which viewed the industrial sector as its driving force.

There are obviously regional differences in the pattern of employment. In the south and the north-east regions the primary sector is more important, the north-east being the largest employer of labour in this sector. In the south-east industry is more important in terms of employment. Despite these differences, the main employer in all regions except the north-east is the service sector, which employs between 42 per cent of the labour force (in the south) and 68 per cent (in the north).

2.2 Labour market segmentation

A proper analysis of employment in Brazil cannot ignore the segmentation of the labour market, as the informal sector certainly accounts for a considerable proportion of the economically active population. Attempts to measure the size of this sector are very rare and existing statistics are based on different indicators, so that reliable estimates cannot be made. Nevertheless, it appears that the formal labour market absorbs about 40 per cent of the working population, the majority of workers being in the informal sector.

The vast majority of workers in rural areas are in the informal sector, as only 2 per cent of rural activities in the primary sector are included in the formal labour market. In urban areas formal sector jobs slightly outnumber those in the informal sector, which accounts for about 45 per cent of workers. There seems to be no significant difference between industry and services in the degree of labour market segmentation.

The definition of "informal sector" implies low productivity, low pay and little (or no) protection for the workers. Despite this, the exercise of informal activities can often result in higher pay than some occupations in the formal labour market and may thus constitute a deliberate job option for certain workers. The economic crisis of 1981-83 resulted in severe job losses throughout the country and many unemployed workers moved into informal activities, setting up small family businesses, such as car repairing or dress-making, and trading as street vendors. Such activities were comparatively profitable, so that many of these workers did not return to the formal sector even when the economic situation improved and more jobs were available in 1985-86. It thus appears that the negative aspects contained in the definition of the informal sector do not necessarily apply to all the activities included in this category. It is quite probable that the informal sector, at least in urban areas, includes reasonably productive occupations generating higher incomes than the formal sector.

2.3 The formal sector (industry)

In the formal labour market 65 per cent of the jobs are in services, 31 per cent in industry and 4 per cent in primary activities. As this study concerns training workers for industry, this section will deal only with the distribution of employment in manufacturing and construction.

The construction industry is the biggest employer, with approximately 13 per cent of the total labour force employed in the industrial sector. Next, with 11 per cent of the total, is the food industry, followed by garment manufacture, footwear and cloth products, metallurgy, textiles, transportation material and the machine tool industry, all absorbing between 5 and 10 per cent of the industrial workforce. These branches together account for approximately 60 per cent of employment in industry, in addition to the 13 per cent absorbed by construction.

The majority of industrial workers (about 66 per cent) are machine operators and vehicle drivers. Workers in the scientific, technical and artistic occupations account for nearly 6 per cent of the total. The category that includes office workers (12 per cent) and other trades and services (6 per cent) accounts for about 18 per cent of the industrial workforce. The category that includes top management accounts for only about 1 per cent of workers in industry.

It is striking that administrative support activities account for almost 20 per cent of the industrial workforce. This ratio seems high in view of the fact that computerisation first reached industry through such administrative procedures as accounting, payrolls and asset controls. Apparently computerisation did not significantly reduce the numbers of office workers.

2.4 The composition of the labour force

The labour force formally employed in industry consists mainly of relatively young males with little schooling, women workers representing less than 25 per cent of the workforce. Although female participation is consistently low throughout the sector it varies somewhat between industries, being higher in branches such as textiles, footwear and clothing and electrical and communications materials. Women workers are mostly in low skill/low wage occupations, and in traditional jobs such as weaving (in the textile industry) and sewing (in the clothing industry). In the electronics industry female labour is used on a large scale in the assembly of components, which demands characteristics considered typical of women - patience, care and manual skill.

It should be pointed out that industry and the formal labour market do not constitute the most important sectors for the absorption of female labour. Women are most active in the service sector which employs 69 per cent of working women; only 36 per cent of female labour force participation is accounted for by the formal sector.

From the point of view of age, the formal industrial sector employs a relatively young contingent, half of the workers being under the age of 29, while 29 per cent of workers are in the 30-39 age range. This distribution matches that of the population of Brazil generally, where 53 per cent of the inhabitants are under the age of 18 and only 13 per cent are over the age of 50.

Approximately 5 per cent of the industrial labour force consists of workers under 18 years old, i.e. minors. This category, which includes about 300,000 workers, is the group which must receive most attention in vocational training programmes. Authors are unanimous in stating that an early entrance into the labour market forces young people to join the ranks of the lowest paid workers in the industrial structure, and thus constitutes a handicap to promotion and goes on swelling the ranks of unskilled adult labour.

Table 1. Educational attainment of the industrial labour force, 1985

Education	Share of the labour force (per cent)
Primary education *	
Incomplete	70.0
Complete	10.7
Secondary education	
Incomplete	5.6
Complete	7.6
Higher education	
Incomplete	2.2
Complete	3.9

* Includes: 22.4 per cent with a maximum of fourth grade not yet completed; 29.6 per cent who have finished the fourth grade; 17.5 per cent who have finished the fifth, sixth and seventh grades grades but not yet completed the eighth grade.
Source: MTb - Anuario RAIS - 85/Brasil

It must be pointed out that only a small percentage of minors who are working are employed in industry in the formal sector. For each minor employed in the formal sector there are about ten working in the informal sector, and for every ten minors in the formal industrial sector there are 12 in the service sector. In short, the minors employed in the formal industrial sector represent only 4 per cent of Brazil's minor workers.

With regard to education, a characteristic of industrial workers in the formal sector is the low level of schooling, 70 per cent lacking even the minimum eight years of compulsory education. Only about 11 per cent of this contingent have completed the minimum eight years of compulsory schooling, and only 20 per cent have had more than eight years of education. Obviously, the educational level of industrial workers reflects the condition of the whole population, whose educational level is very low.

Apart from the broader issues stemming from the low level of education, it is important to be aware of the innumerable problems this poses for vocational training. An individual who is to benefit from vocational training must have a minimum level of education and basic knowledge in order to assimilate the principles involved in the various occupational skills. This becomes even more critical in the case of introducing new technologies since the recycling and training of workers to use new technology is based on the assumption that the worker has a minimum of schooling.

3. VOCATIONAL TRAINING FOR THE INDUSTRIAL SECTOR

3.1 Origin and evolution of the system

Vocational training in Brazil is carried out by a large number of institutions of the most diverse types, some being part of the regular educational system while others belong to the non-formal sector. Non-formal education has recently grown and increased its production very considerably, so that it may be considered as a second educational system.

A quick review of the development of education and vocational training in Brazil shows that collaboration and co-ordination between the two systems did not always exist; even within one system parallel but separate courses coexisted with no communication between them.

Vocational education in Brazil, in an elementary form, goes back to the colonial period when the sugar mills sought to teach their slaves and other workers the basic knowledge needed for the performance of their work.

The Jesuits also played a role in the early days of vocational training in that they improvised as "masters of trade" and prepared officials of the city governments in the techniques of building bridges, roads and defence works. Training was given on the job and learning was by imitation, with all the advantages and disadvantages of this type of procedure; on the one hand itpermitted practical solutions to be found as problems arose, while on the other hand it established as the main goal of training the most perfect imitation of the master's work.

This type of vocational training continued with no basic alterations until the end of the nineteenth century. It was carried out in a context of strong prejudice against manual labour, stemming from the pro-slavery regime which lasted until the end of the nineteenth century and which associated manual labour with the figure of the negro slave. To this day a classical academic education is the ideal for the education of the élite.

Despite widespread prejudice the first institutions for vocational training began to appear early in the nineteenth century. These were aimed at the support of indigent minors and were based on the theory that it is necessary to prepare workers before they begin working, and that the teaching of an occupational skill is a specific activity. However, the image of vocational training was still that of a form of welfare, which strengthened the prejudice against manual occupations.

Significant advances in the field of vocational training took place at the beginning

of the twentieth century when legislation was passed which created schools specifically designed for training workers and which also set up schools of apprentice craftsmen in all the states. This permitted the creation of a federal network of vocational training centres.

In spite of this development, the stereotype of the "dirty hands jobs", and of training for the poorest and "least gifted" students still persisted. This meant that there was still a marked separation between academic education and vocational education even after vocational education had been raised in status and integrated into the educational system.

When Brazil slowly began to industrialise, new industries faced the problem of a severe scarcity of labour. At that time vocational education was still considered appropriate only for the lowest socio-economic levels of the population, while academic education served the élite. The two types of education were organised quite independently and separately. This meant that students in vocational courses could not transfer to the academic courses, and vice versa. It also meant that graduates of vocational courses could not continue their studies in the academic system.

As industry diversified pressure grew for the expansion of vocational education. Although the school network had grown, accelerating industrialisation was creating an ever-widening gap between manpower needs and the training capacity of the educational system. Various attempts were made by Government and industry to solve the problem, and in 1942 this resulted in the creation of the National Service of Industrial Apprenticeship - SENAI.

3.2 National Service of Industrial Apprenticeship - SENAI

SENAI was created by federal legislation and is maintained by a quasi-tax contribution from companies in the fields of industry, land transport, communications and fishing, equivalent to 1 per cent of the monthly payroll. This is the general contribution. Besides this income, the institution also receives an additional contribution from companies with more than 500 employees, which is equivalent to 0.2 per cent of the monthly payroll. SENAI is a sui generis corporation and is defined as a private enterprise for the rendering of service of public or social interest, audited by the Federal Audit Court. It is structured on a federal basis and is made up of regulatory and administrative bodies with representatives from the Ministry of Education and the Labour Ministry on its governing council. It works under the supervision of the National Confederation of Industries and the State Federations of Industries.

The creation of SENAI represented a new approach to vocational training in that its subordination to industry implies the transfer of responsibility for vocational training to private enterprise. It also created a new "client". Industry, not the "least gifted individual" is now seen to be the beneficiary of vocational training, and the welfare image is eliminated. With the creation of SENAI, then, the main respon-

sibility for training was transferred from the Government and the formal educational system to the company and non-formal education. SENAI grew rapidly and was successful in expanding vocational training for industry. In the early 1940s vocational education grew faster than any other branch of the educational system and the network of industrial schools expanded from 143 schools in 1940 to 1,368 in 1945.

3.3 Vocational education in the formal educational system

With intensifying industrialisation and urbanisation the demand grew for proper co-ordination between the vocational and academic branches of the formal educational system. In response to this demand the first "equivalence laws" were passed in the early 1950s, permitting students to transfer from vocational to academic courses. These laws were quite progressive compared with the practice in some more advanced countries which still had dual educational systems at that time.

In the 1950s a number of changes were introduced into the educational system which produced noticeable effects on vocational training. These changes were designed to establish a closer relationship between education and industry, better integration between formal and non-formal education and more responsibility for vocational training within the formal educational system. This process culminated early in the 1970s with the transformation of all regular secondary school courses into vocational courses, with equivalence valid for certain SENAI courses. The formal school system began to include typical vocational courses which had not previously been a part of the curriculum.

This new approach was influenced by the themes that dominated the debate on education at that time. Educational planners were strongly influenced by the "manpower approach" to education and by the theory of "human capital", which caused the meaning and purpose of education to take on a utilitarian character. It should be noted that during the 1960s higher education also became the object of several laws that sought to achieve improved productivity and a greater commitment to social and economic demands.

However, the object of compulsory vocational education in secondary schools quickly proved impracticable, partly owing to lack of funds and equipment, and partly owing to negative attitudes on the part of industry. During the 1980s new legislation was approved to allow greater flexibility at the secondary school level and to withdraw the compulsory vocational courses, although preparation for work was still part of the curriculum.

3.4 Tax incentives for vocational training: Law 6.297

In 1975 the Government created a new type of financial resource and a new type of network aimed at expanding vocational training in the country. The Law on Tax Incentives for Vocational Training (Law 6.297) permitted companies to deduct double the expenses incurred in vocational

training projects from their income tax, to a maximum of 10 per cent of their taxable income. This law thus potentially provided every company with funds, which they deducted from their tax, to be invested in the vocational training of their employees. Many companies thus became vocational training centres, which expanded the training facilities available in the country to a very considerable degree. In addition to its practical results the law promoted a new "philosophy" of training by promoting the idea that the company is the best institution for the training of workers.

Law 6.297 clearly attributed responsibility to the idustry for preparing its own labour force. Further, it was not the institutions of the industrial sector, such as SENAI, but the production units themselves which were to take responsibility for training at least part of the workforce.

The provision of tax incentives produced an immediate response from the business community. Already in 1976 it was reported that 450,000 workers (all sectors) were being treated through the use of tax incentive funds; in 1978 this number rose to 1.5 million trainees, and in 1984 came to just over 2 million.

3.5 Independent vocational training courses

While the training given through the educational system, SENAI and industry was being organised and co-ordinated, private training firms were also offering courses independently to prepare workers for the occupations in greatest demand in industry. Such privately run courses spring up in response to local demand for their services and the size of the network is not known, although there are indications that a considerable number of workers follow these courses. Independent schools only offer certificates of achievement and/or completion of courses, which are not valid for transfer to the formal system. The aim of the people attending these schools is to acquire knowledge and skills that will increase their productivity and employability.

As the number of institutions carrying out vocational training expanded and diversified it became necessary to impose a common framework in accordance with government guide-lines. Accordingly, in 1976 the National System of Professional Training (SNFMO) was created by the federal Government in conjunction with the Labour Ministry, represented by the Federal Labour Council (CFMO). The SNFMO aims at establishing rules and guide-lines for defining the national policy of human resource development, seeking its harmonisation with permanent education.

3.6 The National System of Professional Training - SNFMO

The National System of Professional Training was designed to co-ordinate the work of all the institutions that offer some type of work preparation for children, youths or adults. The innumerable institutions that make up SNFMO are linked to the Federal Labour Council but, in practice, this does not ensure effective co-ordination as each

entity is independent in its decision-making and in its funding. Over ten years after its creation SNFMO had little information on its own real dimensions. It is well known that its statistics exclude the independent vocational schools, of which there were estimated to be over 1,000 in 1976 in the City of Sao Paolo alone. Despite its many shortcomings SNFMO provides some important information on the state of vocational training in Brazil. For example, in 1984 it recorded about 4.4 million enrolments and 140,000 training courses offered by the various institutions of the training system (see table 2).

Table 2. Enrolments in the national system of vocational training in Brazil - 1984

Agencies	Enrolments		Average hour/load
	Number	Per cent	
Law 6.297	2 077 035	47.1	99
SENAC	795 825	18.0	58
SENAI	762 749	17.3	180
SENAR	189 177	4.3	8
MEC	55 526	1.3	605
Tax exemption agreements	205 201	4.6	144
Others	328 253	7.4	23
Total	4 413 766	100.0	78

Source: MTb/SSINFMO - 1984.

3.7 Industrial apprenticeship

The decree that set up SENAI in 1942 also instituted a system of industrial apprenticeship, under the supervision of SENAI. The duties of SENAI were to organise and administer apprenticeship schools and to provide, within these schools, continued education and courses for industrial workers not subject to apprenticeship.

Complementary legislation defined the concept of the apprentice- employee. There must be a three-year work contract between the employer and the minor worker, during which the apprentice is paid less than the minimum wage but receives systematic training for the job. Apprentices are required to be aged between 14 and 18, to have completed the fourth grade of primary school and to have passed an aptitude test. The legislation provides that companies are obliged to enrol a number of apprentices equal to a minimum of 5per cent and a maximum of 15 per cent of workers whose jobs require vocational training in SENAI schools.

The legislation provides that apprenticeships be carried out in one of the two following ways. The apprentice must either be:

- enrolled in a recognised course in a SENAI school, known as an Industrial Apprenticeship Course (CAI);

or

-undergo on-the-job training within the firm, known as Methodical On-the-job Apprenticeship (AMPE). This type of training is given if no SENAI course is available.

3.8 Training needs

Studies analysing jobs in industry usually classify them into five groups: unskilled labour; semi-skilled labour; skilled labour; jobs requiring technical training; jobs requiring higher education. It is estimated that these five categories cover 78 per cent of the industrial labour force, with 22 per cent working in administration. The proportion of workers in the different categories is as follows: 11 per cent unskilled, 47 per cent semi-skilled, 17 per cent skilled, 2 per cent technical, and 1 per cent requiring higher education.

The semi-skilled, skilled, technical and higher education categories, i.e., 67 per cent of the industrial labour force, require vocational training. As the total number of workers formally employed in industry amounts to just over 6 million, this means that over 4 million workers require training (3 million semi-skilled, 1 million skilled, 120,000 technicians and 60,000 professionals).

Vocational training in Brazil is carried out by various agencies of the formal educational system, the non-formal network, and through arrangements where these are complementary.

3.9 The formal educational system

The educational system is made up of three levels, each composed of several grades. Primary education consists of eight grades and is obligatory and free of charge for children from seven to 14 years old. Secondary school consists of three or four grades and aims to provide a good level of general education. Vocational education is given in technical courses in secondary schools which thus provide both academic and vocational education. Higher education, at college or university, lasts for four to six years depending on the course. Schools may be run privately or by the Government at federal, state or city level. The majority of schools belong to the public system while most institutions of higher education are privately run.

There is a schooling alternative called "supletivo" (complementary/ remedial course) aimed at adolescents or adults who did not finish primary and/or secondary school. Complementary schooling offers courses given in schools or by the mass media and leads to a certificate of completion of studies. It also includes apprenticeship and vocational courses given by such institutions as SENAI.

A general criticism of the formal educational system is that it has little relevance to the needs of the labour market. Secondary schools and their pupils are much more interested in preparing for higher education than in preparing for working life. Colleges and universities have more students in the humanities, which are still considered appropriate for the élite, than in the sciences and other subjects related to the economic needs of the country. For the acquisition of knowledge and skills relevant to the labour market, Brazilian workers rely more upon non-formal education than upon the school system.

3.10 Training outside the formal educational system

The main institutions offering non-formal training are SENAI, the firms benefiting from the tax incentives provided by Law 6.297, and the independent vocational schools:

3.10.1 SENAI

SENAI can be considered as both a formal and a non-formal training agency. Two of its courses are equivalent to the formal system - the Industrial Apprenticeship Course (CAI) and the Professional Qualification (HP) - while its other programmes are classed as non-formal.

In 1986 SENAI had 711 operational units and enrolled nearly 750,000 students, mainly skilled and semi-skilled workers.

A sister institution, the National Service of Commercial Apprenticeship (SENAC) trains personnel for occupations in the administration of industry.

3.10.2 Law 6.297

We have seen that the law granting tax incentives for in-company training has made an important contribution to vocational training. However, analysis of firms benefiting from the law shows that only 1 per cent of the total declarers of income tax are in fact applying its provisions; the majority of firms benefiting are big industrial companies in the south-east region. It appears that the law encouraged and consolidated training activities in companies that had already developed such programmes but has not succeeded in creating training structures in companies that did not already have them.

3.10.3 Independent vocational schools

This sector of vocational training is not well known as it is not subject to federal legislation. However, it is clear that the independent sector caters to a very considerable number of students through correspondence courses as well as training given in schools. One estimate put the number of enrolments in correspondence courses at 250,000 in 1980, and another study, already mentioned, found that there were more than a thousand independent vocational schools in Sao Paolo alone in 1979. The courses are not officially recognised and prepare mainly for low-status jobs. The fees are lower than those charged by the private schools operating in the formal system, and they seem to cater for the poorest classes of society.

4. TECHNOLOGICAL CHANGE IN BRAZILIAN INDUSTRY

The key to success in international trade is in the use of new technologies, which raise productivity and increase the competitive advantage of countries that are able to keep pace with technological change. The economy of Brazil is among the ten largest in the western world and the country has a sizeable share of international trade. For example, it exports vehicles to Scandinavia and the United States, aeroplanes to the Federal Repblic of Germany and the United Kingdom, and armaments to several countries of the Middle East. In order to have an idea of Brazil's future prospects in international trade it is necessary to determine the present situation and future potential of the economy with regard to the adoption of advanced technology.

4.1 The development of new technologies

New technologies, high tech, high technology, state-of-the-art technology, advanced technology are all expressions describing the use of sophisticated and complex technology. High-tech companies are not only those dealing in microelectronics or computers; the term includes all companies which develop products or processes based on the systematic application of scientific and technical knowledge and the use of advanced techniques. Microelectronics, the laser, biotechnology, holography and optical fibres are all classified as new technologies. Microelectronics is perhaps the most important owing to its applications in numerous fields, including the manufacture of capital and consumer goods; the others have a more limited application.

Analysis of the development of new technologies in any particular economy has to consider both the country's capacity to create innovations and its capacity to absorb them. Brazil fulfils the minimum conditions for scientific and technological research but its output is very limited, so that companies prefer to purchase foreign technology in the form of licenses and patents.

In 1983 the existence of 1,278 research institutions was registered in Brazil, 1,075 of which were private companies. The rest included public companies, teaching institutions, research bodies and government foundations. Such organisations are highly concentrated geographically, over 70 per cent of them being located in the four States of Sao Paulo, Rio de Janeiro, Rio Grande do Sul and Minas Gerais. It is estimated that 32,000 researchers work in these institutions, the most highly qualified of whom are associated with universities. Brazilian researchers are publishing more and more frequently in international scientific literature.

With regard to the basic conditions necessary for the creation of new technologies, Brazil has already achieved a reasonable degree of industrial development, has an educational system containing elements of excellence comparable to the most highly developed systems of the western world and is trying to achieve effective co-ordination and administration of scientific and technological research. The National Council of Scientific and Technological Development is responsible for implementing a national framework for technological research and development and is charged with approving the plans for scientific development. Nevertheless, despite this basic infrastructure, Brazil's achievements in the field of new technology are still quite limited.

Funds available for research are insufficient and have declined in recent years: national investment in science and technology dropped from 0.7 per cent of GDP in 1982 to 0.5 per cent in 1984. (The expenditure of the developed countries on this type of research regularly amounts to more than 2 per cent of GDP.) Nearly half the funds spent on research come from big business conglomerates. After these, the largest investments are made by the steel industry, machine tools, pharmaceuticals, food and chemicals, which together account for 37.5 per cent of research funds. As a result of insufficient funding Brazil's contribution to the invention and creation of new technologies is quite negligible on the world scale. It is probable that Brazil could develop its own new technology if more funds were available but it is cheaper and less risky to import it. Most of the technology appropriate to the needs of Brazilian industry is already on the market, and to ensure the competitiveness of its exports the country only needs to keep pace with new developments.

Nevertheless, there are a number of cases where Brazilian industry has succeeded in developing new technologies. One example is the automobile industry which developed an alcohol-fueled engine; another example is the arms industry which is the sixth largest world exporter of arms, owing to its development of "intermediate" arms which incorporate the most advanced technology but remain simple to use; a third example is the computer industry which developed its own microcomputers, thus increasing productivity and eliminating dependence on imports so that Brazil now exports computers.

4.2 The dissemination of new technologies

The technologies most commonly used in Brazilian industry are in the field of microelectronics. Microelectronics equipment used in production processes can be grouped into three main categories: machine tools with numerical command; robots and computers. It is mostly in the growing use of machine tools equipped with numerical command that microelectronics equipment is advancing in Brazilian industry. In 1987 the country had 3,970 items of equipment with computerised numerical command, 87 robots and 611 stations for computer-aided design or computer-aided manufacture. It can be seen that the use of

microelectronics equipment in Brazil is still very limited compared with the technologically advanced countries. The process of dissemination and absorption is really still in its initial phase. Companies are slow in introducing innovations and the new equipment coexists with the old, so that it is integrated into the conventional work processes.

In order to study the dissemination of new technologies a survey was carried out by SENAI-SP in the State of Sao Paulo between 1984 and 1987. The survey covered the machine tool industry, publishing and printing, textiles, automobiles and the construction industry. The whole research project covered 63 companies in the state. Four of these branches, i.e. machine tools, printing, textiles and construction, are the subject of the case studies reported in the next chapter so the results of the survey are presented very briefly here.

It was found that in the machine tool industry new technologies were associated mainly with microelectronics, specifically with the use of numerical commands. In the printing industry their main use was in computerised equipment for text composition and image processing, mainly electronic/digital photocomposers and scanners for electronic colour selection. In the textile industry two new machines have brought about radical changes in the production process; they are the automatic loom and the open-end spinning machine. In the construction industry the concept of new technology was extended to cover any new equipment which changed work procedures and job content. A number of new types of equipment are being introduced into the industry which would come under this definition; they are described in the case study on the construction industry.

The surveys showed that new technologies are generally adopted by very few production units in each sector and that even in the companies that introduce them they represent only a small proportion of the total equipment.

It was found that in 1983, 189 machine tool companies out of 13,156 in the State of Sao Paulo had tools with computerised numerical command. In the companies which had this equipment there was a ratio of one advanced machine to 18 conventional ones, and the new technologies accounted for only 5 per cent of total plant equipment. In primary industry new technologies have been introduced in the development of computerised work processes, but their use in word processing was limited to 18 per cent of the companies surveyed, and in image processing even fewer companies had technologically advanced equipment. It was found that electronic/digital photocomposition systems coexist with conventional systems in most companies, but that the use of scanners in image processing completely replaces conventional technology. This case is exceptional, because it is much more common to find new and traditional equipment in use at the same time. In the textile industry it was found that the advanced open-end spinning machines and automatic looms account for 12 per cent of existing equipment. Open-end spinning machines represent only 1 per cent of all

spinning machines while 20 per cent of the looms are of the automatic type. In the construction industry a considerable range of new equipment is being introduced, but again only by a minority of companies. The technologically advanced machines include shield machines, motoscrapers, asphalt and concrete cutters and computerised cranes, among many others. Generally, the new technology coexists with the old, and workers need to be familiar with both.

In summary, the survey data show that Brazil is in a transition phase: the dissemination of new technologies is slow and their use is much less common than in advanced countries. New technologies are attractive to Brazilian industry for reasons of increased productivity, improved product quality, greater precision and more flexibility. The reduction of labour costs is not among the main motives for introducing new technologies, probably because labour costs are very much lower than in the more developed countries.

5. NEW TECHNOLOGIES AND MANPOWER NEEDS

CASE STUDIES

5.1 The machine tool industry

The main technological innovation in the machine tool industry is computerised numerical command. This is a device capable of receiving, compiling and transmitting information about the piece to be made to the machine tool to which it is connected. This allows a whole sequence of operations to be carried out without the intervention of the operator. Machine tools with numerical command carry out the same functions as conventional machine tools, but code the instructions in a programme which is transmitted numerically to the machine. It is possible to programme very complex movements, rotations, change of tools and measurements.

A machine tool with numerical command is made up of three parts: the mechanical part, i.e. the machine itself; the electronic panel, which contains the controls for the servo; and the numerical command, which is the electronic equipment for transmitting information. The introduction of machines with numerical command creates a demand for "programmers" and also brings about some changes in the job content of other workers. In the conventional process, the milling of parts involved several different types of operation. They related to the planning of the work, the preparation of the machine and the actual production of the parts. These tasks were performed by three occupational groups - processors, machine preparers and operators.

Analysis of work organisation in plants using numerical commands shows that programming activities are superimposed on the functions of the former process technician or processor, thus extending this worker's job profile. Knowledge of the process is essential to programming, which has no independent content to justify the appearance of a new occupation. For this reason programming skills are added to the existing skills and knowledge of the processors.

The work of the machine preparer is affected by the new technoloy since the operations involved are usually absorbed into the work of the machine tool operator. The tendency is to combine the work and create the new job category of operator-preparer. The machine preparer will thus disappear as a specific occupation, although the tasks of preparing the machine are maintained in the new system.

The work of the operator of machines with numerical command is closely related to that of the operator of conventional machines. The tasks involved in actual production are much reduced as the machine practically does the work alone. In contrast, the activities of work preparation (preparing the machine and the tools and testing the programme) become more complex and demand new knowledge and skills. The operator participates in programming, as experience in operating the machine is essential for this. There is thus a certain restructuring of the job profile of the machine operators in that they take over some of the activites of the former machine preparers and also take part in programming. These gains compensate the losses due to the simplification of the actual production of the part, which is done almost entirely by the machine.

In addition to the occupations directly connected to the functioning of machine tools, numerical command also affects activities related to maintenance and to work supervision. Maintenance workers have to acquire new skills as the electronic component in numerically controlled machines requires maintenance not required in the conventional system. The numerical command itself is a "black box" and its maintenance is the responsibility of the manufacturer, but the functioning of the three components of a machine tool equipped with numerical command as an integrated system is the responsibility of the maintenance personnel in the plant, and thus adds to the skills required of them.

The introduction of machine tools with numerical command has an effect on the work of the supervisor, who loses control of the operations to some extent. This is because direct and close contact between operators and programmers is essential for preparing the machines; the programmers/process technicians have the theoretical knowledge for preparing the machines while the operators have the practical experience necessary to perceive errors in programming and to suggest solutions. The supervisor is excluded from this liaison work and thus loses part of the control over the production workers.

Generally, as a result of introducing new technology in the machine tool industry no new jobs appear and the content of existing jobs does not change substantially. This is due partly to the fact that, as yet, very few companies have work teams specifically assigned to the new machines. Thus, the activities that may be created by work on such equipment are simply added to the profile of existing occupational categories. The combination of mechanical and electronic skills necessary for work on microelectronics equipment has been given the name "mechatronics" in the literature on the subject. It is expected that workers skilled in mechatronics will be increasingly in demand as new technologies become more common in the machine tool industry in Brazil.

5.2 The printing industry

As already mentioned in Chapter IV, new technologies in printing and publishing take the form of electronic-digital

photocomposers and scanners for the electronic selection of colours.

Electronic-digital photocomposers constitute complete photocomposing systems and consist of:

- text introduction via a keyboard with video monitor;
- text storage in a central unit, either direct or on disks;
- correction system on video or printer-aided;
- electronic pagination system with video preview;
- final photocomposing processing unit.

Text composition by means of this equipment is a radically different process from the earlier methods of manual or mechanical composition. Manual composition was based on the grouping of the metal or wooden "types" by a typographer, and mechanical composition was carried out using machines equipped with a keyboard, in which composition was complemented by "casting" of the types, which was carried out by linotypists, monotypists or intertypists, the precise designation corresponding to the name of the machine. In this system text composition consisted of the casting of metal sheets or plates that served for printing the original.

In photocomposition systems text composition is carried out by operating a keyboard which activates a system for exposing the types on photographic material which is then processed by a photo-offset or photo mechanical process. The work is done directly onto the film and thus eliminates the need to produce a negative by conventional photographic processes.

The first photocomposition systems were based on optical-mechanical principles and the latest systems are based on electronic-digital principles. The real technological revolution in printing was in the passage from mechanical composition to direct printing composition, since this involved changes in the work processes, in equipment, raw materials, manpower needs and skills. The change to the electronic-digital systems brought about further modifications in work organisation, but these were much less radical than in the transition from mechanical to direct printing composition.

The operation of a photocomposer requires a keyboard operator and a photocomposer operator. The text is introduced into the system through a keyboard with video monitor: the work of the keyboard operator is fundamentally different from that of the manual composer or typographer. The new technologies have eliminated the tasks carried out by these two occupational groups and have created different and new functions. The work has been very much simplified and the level of qualification required is eight years of formal schooling, i.e. a full primary education. Previous experience in typing or keyboard operating on computer terminals is desirable but not essential.

In the traditional processes text composition and the "programming" of the composition were performed by the same worker. In the present system these activites are divided between the keyboard operator and the photocomposer operator. The introduction of photocomposition systems has created the new occupation of photocomposer. The photocomposer controls the equipment which reproduces the texts by analysing the originals, observing the typographical symbols, feeding and removing the film and correcting the texts. The photocomposer operator thus inherits part of the work previously carried out by typographers and linotypists, but the work is done in a way that is completely different from the conventional system. Operators are usually recruited among typists, keyboard operators and tape or card punchers; no knowledge of conventional printing processes is required. In the transition from optical-mechanical to electronic-digital systems very slight changes occur in the job content of both the keyboard operator and the photocomposer operator, but little training is required for the workers to adapt to the new system.

The effects of the appearance of computerised photocomposers are not limited to the tasks immediately associated with the equipment itself but extend to the whole process of text composition and printing. Modern technology eliminates the stage of producing negatives by conventional photographic processes, thus eliminating the tasks formerly carried out by photographers and photo-offset retouchers.

The second type of new technology which is making an impact on the printing industry is the scanner. This equipment is used to carry out the electronic selection of colours, which is one stage of image processing. In the conventional system this involved the following steps:

- photographing the original to obtain negatives;
- retouching the negatives;
- developing the negatives;
- retouching the prints;
- assembling the text and image;
- engraving on aluminium plates;
- printing.

Before the advent of scanners, photographs had to be treated manually, and for colour photos the retouching and developing had to be done separately for each of the basic colours. The technologically advanced scanner obtains the print from the photograph, thus eliminating the processing stages, and it operates on the four basic colours at the same time. The material produced is of such high quality that retouching is practically eliminated and the speed of colour selection ensures high productivity.

The occupations directly affected by use of the scanner are those of the operator, the photo-offset retoucher and the photo-offset assembler. The operator's work incorporates some functions of the photographer in the conventional system, to

which are added new tasks which still require the knowledge and skills of the photographer. There is thus an increase in the level of qualification required for operators compared with photographers in the conventional system. Operators are mostly recruited from employees already working in photomechanics within the company. The job requires considerable experience in conventional printing processes, plus specific training in using the electronic colour selection equipment. Owing to the high productivity of the equipment, the demand for operators tends to be smaller than the demand for photographers in the conventional system. In contrast, the high productivity of the scanner greatly increases the amount of work sent to the assembly areas. Consequently, there are more jobs available for photo-offset assemblers. In the case of photo-offset retouchers, the introduction of scanners has made their occupational skills obsolete as the quality of the photo-offsets produced has eliminated the need for retouching.

In summary, the introduction of electronic-digital photocomposers and scanners has produced a wide variety of different effects on occupations in the printing industry. Certain occupations, such as manual composers, typographers and photo-offset retouchers, have become obsolete. Where they are replaced by a different occupation, there is a reduction in the level of qualification required, so that the new technologies result in some deskilling. In contrast, the occupation of scanner operator requires a higher level of qualification than the work of the photographer that it replaces. Other occupations, such as that of photo-offset assemblers, experience no real change in job content, but must adapt to a change in the demand for their services resulting from the high productivity of the new technologies. This wide range of effects on employment is perhaps more typical of printing than of the other branches of industry described in the case studies.

5.3 The textile industry

New technologies in the textile industry take the form of open-end spinning machines and automatic looms. The open-end machine is an advance on the ring spinning machine, although at present it cannot replace all the functions of the traditional machine. The open-end machine of today produces only low titration yarn but research is in progress to increase the yarn titration and the machine will certainly be more widely used in future.

The spinning machine produces the yarn and winds it onto spools. It is then wound onto cones and any irregularities are eliminated. The cones then go onto the various stages of the weaving process. The open-end machine is different from the convential ring spinning machine in that it eliminates the stages of combing, drawing and twisting, which were formerly carried out by draw frames. The later stages of transferring the yarn from spools to cones and eliminating irregularities in the yarn are also eliminated. These operations are carried out by the speed frame in the conventional process. Therefore the open-end

spinning machine represents a new system of yarn production, eliminating draw frames and ring frames and all the operations related to these two machines.

The introduction of the open-end machine brings about no great change in the job content of the machine operator, whose function remains basically the same as that of the operator of the ring spinning machine. In both cases, the operator controls the machine and is responsible for maintenance. The new machines need to be cleaned more carefully and more frequently than the old, but have to be checked less often. The task of splicing the yarn is almost eliminated by the new machines, so the job content of the operator is reduced slightly in comparison with the operator of the conventional spinning machines. The main effect of introducing the open-end machine is not felt by the operator but in the elimination of the work stages using the draw frame, where the occupation of draw frame operator has been eliminated. The occupation of cone frame operator also disappears since the work stages involving the cone frame have been eliminated in the same way.

In the weaving operations, which follow the spinning of the yarn, the automatic loom performs most of the functions of the conventional loom and dispenses with the stage of the flyer and all the operations related to it. In the conventional system the yarn from the spinning machine is transferred to pirns by the pirn frame. For weaving to begin, the yarn is then wound onto bobbins by the flyer. In the new system the loom is fed directly by cones which are much larger than the pirns. The automatic loom is more productive than the traditional loom because it reduces the frequency of thread splicing and machine feeding operations. No radical changes are involved in the work of the weaver operating an automatic loom compared with the operator of a traditional loom. The weaver's tasks include cleaning checks on the loom and the warps, checking the metre counter and attaching the tape to the fabric selvage. Some tasks have to be carried out more frequently on the new looms, but others are required less often. The most important effects of the new loom are in eliminating the stages of the work process which involve the speed frame, thus eliminating the occupation of speed frame operator and reducing the tasks of the bobbin winder.

It can thus be seen that new technologies in the textile industry eliminate certain occupations without creating new ones. The work of the machine operators remains essentially the same, so that little training is needed to prepare an operator to work on a technologically more advanced machine.

5.4 The construction industry

Various types of equipment used in the construction industry are classed as new technologies. They include the shield, the motoscraper, the roto-mill asphalt/concrete cutter, the computerised crane, the tender concrete finisher, the concrete cutting machine, the rail fastener machine, the tractor and the movable asphalt plant.

The shield is used for tunnelling. In the conventional process this work demanded a large number of semi-skilled workers to dig short stretches of tunnel, which was done manually, and then to place supports and pump in concrete. The shield integrates these two stages and carries out all the operations mechanically. It also removes earth and debris. The occupation of shield operator has appeared with the introduction of this machine. The content of the new job includes some of the tasks of the operators of hydraulic machines, to which new knowledge and skills are added. It has been found that a knowledge of topography and of mechanics is useful to operators, but the shield does not demand a new set of skills which would constitute a special occupational category. The work of the shield operator is a combination of new and traditional knowledge and skills. However, certain occupational categories disappear with the introduction of this new technology. The use of the shield means that the tasks of the workers who carried out the manual digging and structural support of the tunnels are eliminated by the machine while generally no alternative employment is created.

The motoscraper is used in earth-moving operations. With the traditional technology, earth-moving involved digging, loading, transporting and unloading of material. The motoscraper integrates these stages into one continuous operation and thus performs the function of several types of equipment and the workers who operated them. With the introduction of the motoscraper, the new occupation of motoscraper operator has appeared. The work of the operator is more complex than that of the drivers of the traditional types of equipment. In addition to driving the machine, the operator must control the various functions which were formerly carried out separately. More attention and responsibility is demanded and fatigue is increased owing to the accumulation of operations. Truck drivers or workers familiar with other heavy vehicles are recruited as motoscraper operators. The skills of the truck driver are essential to this occupation, and new skills are added to adapt the worker to the new machine. The motoscraper dispenses with the need for workers to drive power shovels, loaders and dump trucks as all these work stages are performed by the new machine itself.

The roto-mill asphalt and concrete cutter is employed in road maintenance. It recycles and reapplies the asphalt and regulates its thickness. The conventional system of road maintenance involves the separate stages of grading, collecting and applying the material using several types of equipment such as pavers, concrete mixers and trucks. A considerable amount of manual labour is needed. The roto-mill integrates and carries out all these operations and also heats the graded material for reuse. The roto-mill thus replaces several other machines and many manual workers in road maintenance. The occupation of roto-mill operator is created by the new machine; the operator must have the knowledge and skills of all drivers of construction machines and earth-moving equipment and must adapt these skills to the new machine. There is thus a change in the qualifications and skills required but

the operator's work remains basically the same as that of drivers of traditional equipment.

The computerised crane works by the introduction into its computer of data needed for lifting the load and it has no manual controls. The lifting process is similar in conventional and computerised cranes, involving the operations of load evaluation and analysis of the load diagram. The difference is in controlling the lifting operation itself. In the computerised crane the variables such as weight, height and angle are recorded on punch cards. The operator inserts the card in the control panel, thus programming the machine for the conditions recorded. The crane is equipped with a blocking mechanism that stops operation if some movement is required which is not included in the programme. The main difference between operating a conventional crane and a computerised one is that the physical exertion necessary is reduced but the mental effort is increased due to the greater complexity of the work. Mental stress may also be increased by the partial loss of control over the equipment. The skills needed by the operator of the computerised crane are simply an extension of those of the traditional crane operator.

Tender concrete finishers are machines used in the construction of road beds. They mix the concrete, transport it, lay it and at the same time control its thickness. The most important employment effect of this machine is that it eliminates the jobs of the manual workers formerly in charge of spreading the concrete and controlling its thickness. The operator of the tender concrete finisher has a very similar job profile to that of the operator of the traditional concrete mixer; the only added function is responsibility for the thickness of the concrete.

The concrete cutting machine is used in joining concreted areas. The new machine cools the concrete during application which traditional machines cannot do. The operation of the machine is not basically different from the operation of conventional machines.

The rail fastener machine is used to fix railway tracks to the sleepers. The machine takes over all the manual labour, thus making this occupation obsolete. The introduction of this machine creates the entirely new occupation of rail fastener machine operator. The operator has no need at all of the knowledge and skills of the rail clampers who carried out this work in the traditional system.

The introduction of more powerful tractors requires more skill on the part of the drivers. Although there are no changes in the work process a higher degree of skill is required than for driving conventional tractors.

Mobile asphalt plants are assembled on site in order to make asphalt and are then dismantled and moved to another site. This necessitates some reorganisation of the work but the work itself remains the same. The change consists of the need to assemble and dismantle the plant as each site is finished. The work of the operator is the

same as that of the operator of the conventional machine except for the added responsibility of assembling and dismantling the equipment.

The construction industry has traditionally been a big employer of unskilled and semi-skilled labour. Several of the new technologies described above eliminate the need for manual workers without creating suitable alternative employment. Few of the jobs in this industry required much further training to adapt workers to the new machines if they are already familiar with the conventional equipment.

6. THE EMPLOYMENT EFFECTS OF NEW TECHNOLOGIES

Analysis of the impact of new technologies on the industries surveyed indicates that the effects of the innovations are not the same for different branches of industry and different occupations. It is, of course, dangerous to make generalisations based on a very limited number of case studies. Nevertheless, the surveys suggest that the introduction of new technologies produces four different types of effect on job content and employment. They are:

- job restructuring;

- job maintenance;

- job creation;

- job destruction.

6.1 Job restructuring

Job restructuring takes place when the content of a traditional occupation is enlarged by the addition of new knowledge and skills demanded by the transition to new technologies, at the same time as some of the traditional skills are made obsolete by technological progress. There is no break between the new form of the occupation and its traditional content. The worker's knowledge and skills are the necessary foundation for acquiring the additional qualifications, which means that it is not difficult for the workforce to keep up to date with technological innovations. Workers can thus be trained or recycled to learn to perform new functions; it is easy to adapt because there is no conflict between the old and new skills - they are complementary. Recruitment for the new occupation takes place among workers already qualified in the traditional system or work process. Short training programmes are sufficient to prepare workers who already have a basic education, vocational training and practical experience.

In the industries described in the case studies, job restructuring occurs in certain occupations in the machine tool industry, printing and the construction industry. In the machine tool industry the new occupational profiles of operators, programmers and maintenance workers are examples of restructuring. The same thing happens in the printing industry in the case of the scanner operator, a new occupation that demands extensive experience in the conventional processes of printing and photomechanics. In the construction industry job restructuring occurs in the case of the operators of shields, roto-mill cutters, motoscrapers and mobile asphalt plants.

This conversion of workers skilled in the conventional system is an indication of the continuous development of the occupa-

tion, which is able to improve productivity by adapting to new technologies.

6.2 Job maintenance

Job maintenance occurs when the introduction of technological innovations makes little difference to the profile of the traditional occupation. There may be slight alterations which either increase or reduce the original job content, but the overall effect remains marginal. The two processes may occur simultaneously. What differentiates job maintenance from restructuring is simply the extent of the changes experienced. However, in both cases the new skills are acquired on the basis of the traditional skills and there is no break between the old form of the occupation and its new content. Recruitment criteria are not altered, which indicates that the job content is basically maintained after new technologies have been introduced.

Job maintenance is less common than job restructuring. In the case studies presented job maintenance was reported for certain occupations in the textile industry, printing and construction. The operators of spinning machines and looms in the textile industry experience such small alterations in their duties when the new machines are introduced that their case amounts to job maintenance. In the printing industry the occupations of keyboard operator and photocomposer operator can also be classed as examples of job maintenance in the transition from the optical-mechanical to the electronic-digital photocomposition system. Job maintenance occurs in the construction industry in the case of the operators of computerised cranes, tender concrete finishers and concrete cutting machines, and also in the case of tractor drivers.

6.3 Job creation

Job creation is basically different from job restructuring and maintenance since the introduction of new technologies causes such great changes in the work process that there is a total break with the conventional system and previous knowledge and skills are made obsolete. In this case a truly new occupation appears with its own job content, which bears litle or no resemblance to the conventional job profile. In this situation there is no question of giving only short training to adapt or recycle workers trained in the traditional system based on earlier technologies. This does not mean that it is impossible to recycle these workers, but simply that recycling does not depend on their background of knowledge, skills and experience, in the sector.

The creation of new jobs was identified only in the printing and construction industries among the branches surveyed in the case studies. In printing, job creation occurs in the occupations of keyboard operator and photocomposer operator when the transition is made from manual or linotype text composition to an optical-mechanical photocomposition system. As already stated, the subsequent transition from an optical-mechanical to an electronic-digital system results only in job maintenance for the operators. There is no relationship between the content of the

work of the operators of these machines and the tasks carried out by typographers, manual composers and linotypists in the past. The work of keyboard operators and photocomposer operators is more closely related to occupations in the service sector today than to other occupations in the printing industry. In the construction industry job creation occurs in the case of the operator of the rail fastener machine, whose knowledge and skills are completely different from those of the rail clampers whose skills are made obsolete by the new technology.

Analysis of job creation must consider the question of deskilling, that is, the possibiliy that the new occupation is poorer in content than the job it replaces. Unfortunately, evidence collected by the SENAI-SP surveys reported in Chapter V is insufficient to reach any conclusion about the result of the changes in the industries studied. The data seem to show only that new occupations may be either richer or poorer in content than the ones they replace, depending on the type of new technology, the branch of industry and the occupations concerned. The cases of job creation identified in the SENAI-SP research show both results; in the case of the rail fastener machine operator there was decreased physical exertion and increased job complexity. In contrast to this, the introduction of optical-mechanical composition in the printing industry clearly resulted in deskilling. The most advanced equipment requires no knowledge of composition processes or even of the printing industry and its operation is closely related to work in the service sector requiring a low level of qualification.

6.4 Job destruction

Introduction of new technologies can cause job destruction, that is, tasks and operations that existed in the traditional work processes are made obsolete by technological progress. It should be pointed out that the destruction of occupations is not necessarily the same thing as the destruction of employment possibilities, although the elimination of a task or operation always means the destruction of the jobs of the workers who carried it out. Job destruction must be analysed in the broad context of the production process as a whole since the effects of technological innovations are not limited to the immediate production stage in which they are introduced: it is often in the preceding or subsequent stages of the process that the destruction of tasks or operations occurs. The operations that may be affected can be grouped into three categories: main tasks, directly related to operating the equipment; complementary tasks, indirectly related to the functions carried out by the machine or concerned with the transformation of raw materials; and peripheral tasks, related to maintenance and cleaning. The findings of the SENAI-SP surveys indicate that technologically advanced equipment does not usually destroy the main tasks. For example, the traditional ring spinning machine in the textile industry has an operator and this job is restrained with the introduction of the open-end machine; both the traditional and the computerised

crane must be handled by an operator in the construction industry.

The most common occurrence is the destruction of complementary tasks. This usually happens because the new equipment integrates several work stages or else eliminates some stages completely. In the case of the textile industry, the open-end spinning machine eliminates the tasks formerly performed on the draw frame and the speed frame and thus destroys the jobs related to the operation of these machines. The same occurs with the automatic loom which eliminates the use of the pirner so that the job of pirn frame operator is also eliminated. Job destruction also occurs in the construction industry. Manual workers who dig and build tunnels disappear with the introduction of the shield which performs this work mechanically. The same process occurs with the asphalt/concrete cutter and with the roto-mill cutter. The rail fastener machine creates a new occupation and destroys an old one. In the printing industry, modern photocomposers eliminate some of the tasks of photographers and photo-offset retouchers, but their jobs do not completely disappear as some of their skills are still needed in the new system.

It should be pointed out that technological innovations may sometimes have little impact on job content, but may cause changes in the demand for certain occupations. The high productivity of the new equipment may either increase or reduce demand for workers in related occupations, depending on external demand conditions.

7. THE TRAINING IMPLICATIONS OF NEW TECHNOLOGIES

7.1 Initial training

The data presented in the previous two chapters give an indication of the impact of technological innovations on labour in some branches of industry and suggest certain points relevant to the vocational training needed to prepare workers to use the new technologies.

It is important to point out that the new technologies do not put the value of conventional vocational training in doubt. This is because the commonest effect of technological innovations is job restructuring, where elements of the traditional work process are combined with new skills. Vocational training, therefore, cannot neglect the preparation of workers for traditional systems and equipment, but needs to complement this with the specific training required for working with new technologies. An important aspect of this is a thorough understanding of the advanced equipment. This is a subject which requires serious attention on the part of trainers in view of the complexity of equipment specifications. The range of technical specifications for the new technologies already on the market almost requires specific training for each individual piece of equipment, which would not be feasible. The only practical solution for vocational training agencies must be to prepare workers in a general way to use advanced equipment, while giving sound training in all aspects of the conventional work processes.

In the printing industry, for example, in the area of image processing, theoretical and practical training in the conventional processes should be complemented by special training in the use of the scanner for electronic colour selection. In the machine tool industry vocational training should consist of basic theoretical and practical training to permit the worker to keep pace with technological change, together with special training for the new technologies.

The new components of vocational training programmes should cover all aspects of handling new equipment (operation, programming and maintenance) in addition to study of such basic subjects as mathematics, geometry and hydraulics; apart from this, certain subjects essential to the new technologies such as mechanics and electronics, should also be taught. The subject of mechatronics is a good example of the combination and integration of different types of competence that must be acquired. Traditional knowlege of mechanics is essential to workers who will be using technologically advanced equipment, but they also need a sound background in electronics as such equipment has an important electronic component.

Consequently, mechatronics is a new training need.

7.2 Recycling for conversion to new technologies

The need to combine the new with the traditional in training courses is confirmed by the criteria for recruiting workers for restructured occupations. Recruitment takes place among workers who have basic education and training, in addition to practical experience in jobs similar to those created by the new technologies. Relatively short training is required to prepare this type of worker to use technologically advanced equipment. Thus, to effect the conversion of workers, new skills are added to the basic knowledge and competence already acquired. It is not difficult to train suitable workers to adapt to using new technologies, but it must be pointed out that the possibilities of worker conversion are in fact very limited. This is because it is only those with basic education, training and experience who can adapt quickly. Such workers are a small minority of the industrial labour force in Brazil.

It is clear that the new technologies do not make traditional vocational training programmes obsolete. However, such training is not sufficient to ensure a supply of skilled workers for the new technologies, since dissemination of advanced equipment creates new jobs, the content of which bears no relation to existing knowlege and skills. Job creation sometimes results in jobs with relatively poorer content in terms of knowledge, skills or tasks, in comparison to the traditional occupations; this, of course, minimises the problems of vocational training. But where the new jobs are more complex, vocational training must be structured for teaching the emerging skills and the courses will have to be designed to respond to specific situations.

8. CONCLUSIONS

The impact of new technologies is not uniform or necessarily predictable. It depends on the economic and social context of the industries and countries that introduce them. The manner in which Brazilian industry is incorporating advanced equipment is in fact a specifically Brazilian model of transition to the new technologies. The Brazilian case can be understood with reference to the factors that have led the country to enter, albeit cautiously, into the age of new technologies.

Advanced technologies are labour-saving and it is expected that they will perform tasks formerly carried out by workers. Saving on labour costs seems to be one of the main reasons for the adoption of these technologies in the developed countries, where labour represents a large percentage of production costs and where trade unions ensure high levels of worker protection. This is not the case in Brazil, where remuneration of the workforce is extremely low. This means that the labour-saving aspect of the new equipment is much less attractive to Brazilian industry than to industry in the developed countries. Union organisation in Brazil is fragile and the informal sector and unemployment keep wage levels down by ensuring a stock of labour to be mobilised as required by the formal sector.

Research results confirm that the labour saving factor is not included among the most important reasons for the introduction of advanced equipment in Brazilian industry. The most frequently mentioned reasons for adopting new technologies are: increased productivity, improvement of product quality, enlargement of installed capacity, greater precision and flexibility, savings in materials, savings in time, moving into new markets and the customer's belief that they are more reliable. In short, Brazil has found its own justifications for introducing new technologies and has begun to invest in them despite low labour costs.

As a general rule, workers in the lower and middle levels of the hierarchy are able to perform the work created by the new technologies. In the industries surveyed by the SENAI-SP research, there was no resort to university graduates to work on the new machines. It is possible that this is connected with the currently low level of diffusion of new technologies in Brazil. Companies are able to find workers among their own employees with suitable qualifications for additional training to work on the new equipment. In most cases, the threefold qualification of education and vocational training and practical experience is the criterion for selecting workers with the competence needed to

extend their training and enlarge their job profile.

If there were a swift dissemination of new technologies with a consequent big demand for workers capable of operating them, this strategy could become unrealistic owing to the relatively small number of workers who actually fulfil the three basic conditions for recycling. In fact, as we have already seen, the great majority of those presently employed in the labour force lack even the minimum level of basic education. This point raises an important question for the preparation of the labour force for working with new technologies: training for new occupations does not depend exclusively on vocational training programmes, but is also closely related to basic education. Therefore both vocational training programmes and the educational system must be structured so as to ensure that the labour force acquires the necessary competence to face the challenge of the new technologies.

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